

MAY 24 1960

UNION CARBIDE NUCLEAR COMPANY .

POST OFFICE BOX P. OAK RIDGE, TENNESSEE

May 17, 1960

*Accidents -
Incidents*

U. S. Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee

Attention: Mr. S. R. Sapirie

Gentlemen:

Subject: Investigating Committee's Report of the Solid State
Physics Contamination Incident

In accordance with the provisions of Chapter 0703 of the AEC Manual, entitled Notification, Investigation and Reporting of Incidents, we are enclosing twenty copies of the report of the Committee established to investigate the radioactive release in the Solid State Physics Building on April 26, 1960.

For your information, the following action was taken promptly following this incident to preclude similar occurrences in this and other hot cell facilities of the Oak Ridge National Laboratory:

- (1) All hot cells were examined by the Laboratory's Hot Cells and Sources Committee for conformance to the safe operating criteria for hot cells which is presented in Appendix A of the attached report.
- (2) All operations involving significant quantities of radiation were required to be carried out in accordance with a safe operating procedure to be approved by the division director and the Director of Radiation Safety and Control.
- (3) A radiation control officer will be assigned in each division. He, under the division director, will assume full responsibility for radiological safety in the division, actively and aggressively keeping under constant surveillance all operations of the division which could lead to radiation incidents.

This document has been approved for release
to the public by:

David C. Harvey 2/16/96
Technical Information Officer Date
ORNL Site

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May 17, 1960

- (4) Every division director has been instructed to carefully re-examine all of his operations for potential radiation safety problems and to work with Laboratory management in promptly correcting them.

Yours very truly,

UNION CARBIDE NUCLEAR COMPANY



Clark E. Center
Vice President



CEC:FRB:mb

Encl.

cc: J. A. Swartout (2)
F. R. Bruce (LO)

Report
of
Investigating Committee

BUILDING 3025 INCIDENT
Oak Ridge National Laboratory
April 26, 1960

F. R. Bruce, Chairman
D. E. Ferguson
J. A. Lenhard, ORO
G. W. Parker

Report Submitted:

May 17, 1960

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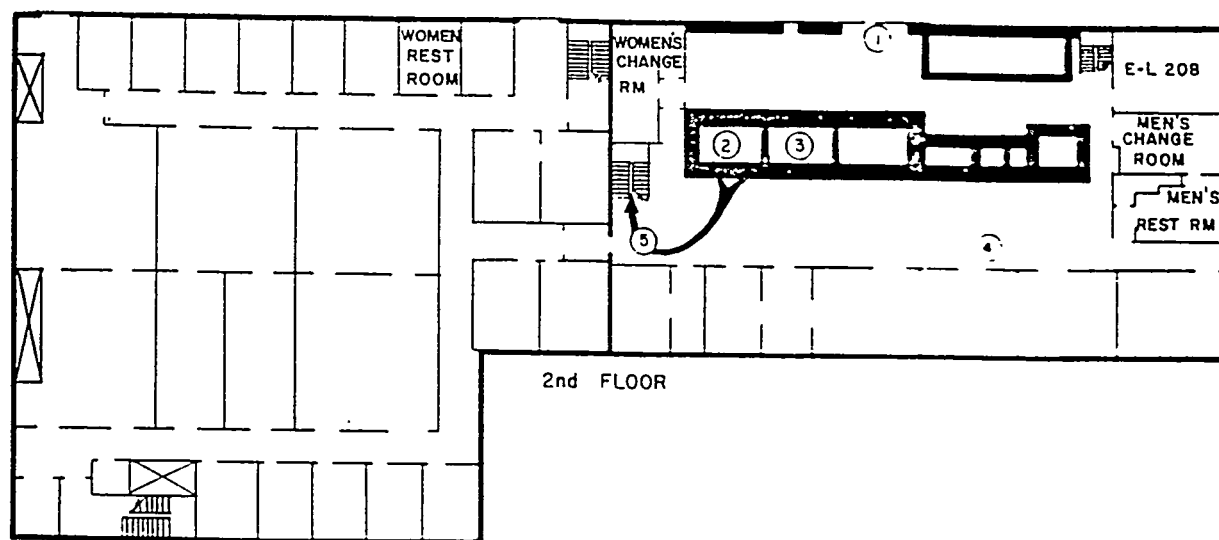
I. Summary

On April 26, at approximately 11:00 a.m., a quantity of beta and gamma active dust, estimated to contain a total of <1 curie of activity, was expelled from Cell 1 in Building 3025. At the time of the release there were 8 persons in front of this cell and directly in the path of the dust cloud. Another 13 persons were in the general hot cell area but not directly in the path of the cloud. None of the exposed individuals is believed to have received in excess of the maximum permissible exposure. Analysis of presently available exposure data, which must still be considered preliminary, indicates one person ingested a quantity of activity which will give a 1.2 REM exposure to both lungs and bone during the first quarter and 2.1 REM during the first year. The next person will receive a 0.3 REM exposure during the first quarter and all others at least a factor of 10 less than the highest exposure. The beta and gamma active dust was distributed throughout the hot cell area and the office-laboratory areas of Building 3025, making it mandatory that extensive decontamination be carried out before any of this building could be used. As of May 12 the estimated cost of cleanup is \$39,500. No significant amount of activity was discharged from the building at ground level and no activity attributable to this incident could be found on the roof of the building where the ventilation system exhausts are located.

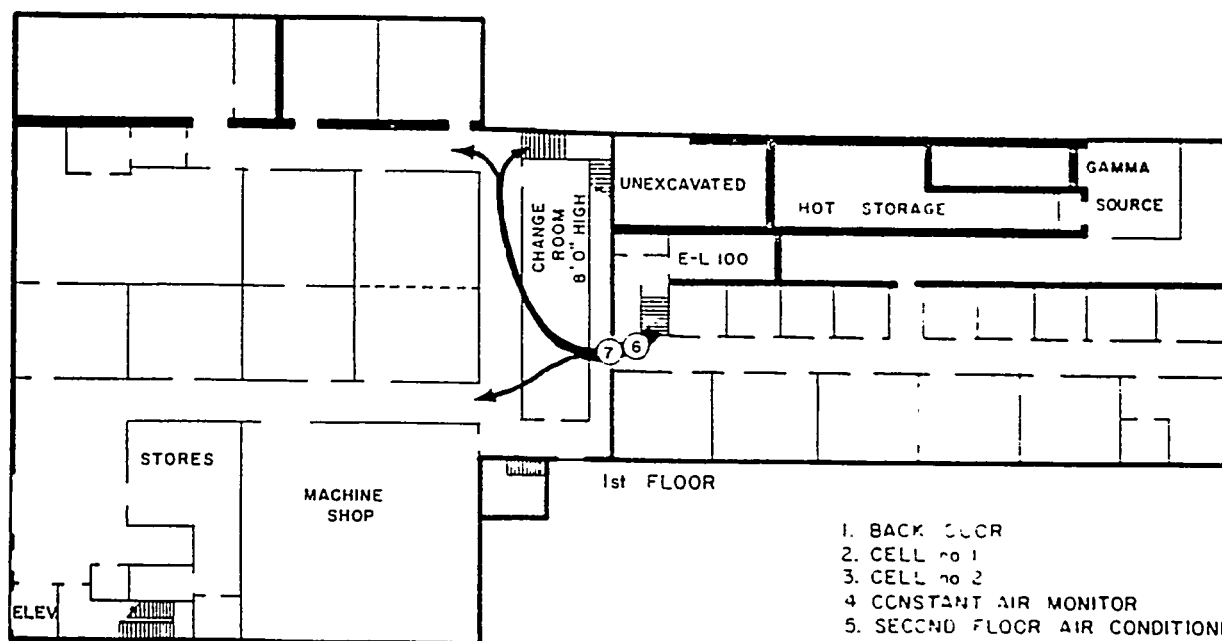
The exact mechanism of the expulsion of this activity from the cell is not known. However, there was a combination of conditions which either singularly or in combination could account for the release. Sawing of a contaminated graphite capsule had just been completed, leaving Cell 1 highly contaminated with a readily air-borne radioactive dust. The pressure drop between the operating area and Cell 1 was observed to be only a few hundredths (.02 to .03) of an inch of water earlier in the morning. An air hose was used to blow some of the radioactive dust off a piece of paper just prior to the incident. Openings in the face of Cell 1 were shielded but not sealed. Alterations to the adjoining cell, Cell 2, were in progress, and Cell 2 was open to the operating area, to the back area, and to Cell 1. The large back door to Building 3025 was open. This set of conditions would allow pressure disturbances created in the back area by the wind to be transmitted through Cell 2 into Cell 1 and blow the activity out the unsealed penetrations in the face of that cell into the operating area.

A floor plan of Building 3025 is given in Fig. 1. The main radioactive dust cloud after leaving the face of Cell 1 was sucked down the stairwell just west of the cell. A large fraction of the cloud was picked up by the air conditioners at the head and foot of these stairs. Most of this activity was caught on the intake filters for these air conditioners. The remainder was then distributed back over the hot cell area. The filters on these air conditioners read 3-4 r/hr after the incident.

The alarm was given at about 11:00 a.m. by a constant air monitor located in the hot cell operating area. A Health Physics representative was



2nd FLOOR



1st FLOOR

1. BACK DOOR
2. CELL no 1
3. CELL no 2
4. CONSTANT AIR MONITOR
5. SECOND FLOOR AIR CONDITIONER
6. FIRST FLOOR AIR CONDITIONER
7. CONNECTING DOOR,
(PROPPED OPEN AT TIME OF INCIDENT)

0 10 20 30 40 50

FIG. 1 BUILDING 3025 FLOOR PLAN

called immediately and evacuation of the area was started as soon as the alarm was confirmed. People leaving the building were monitored and appropriate personnel decontamination procedures used. It was not realized, however, until 3:00 p.m. that the activity was air-borne throughout the building. At this time the ventilation system was shut down and appropriate steps taken to contain and remove the contamination.

As of May 12, in the west section of the building, the ventilation system has been cleaned to the point it is delivering clean air; all offices, labs, and halls have been cleaned and found, with a very few exceptions, suitable for reoccupancy. The second floor of the east end, hot cell area, has been cleaned and spot checks indicate it to be habitable. The basement, however, will require about another week of cleaning.

II. Chronology

April 11, 1960

Installation of equipment for the disassembly and inspection of the irradiated fueled graphite specimen was started in Cell 1 by a group under [REDACTED]. This involved a series of operations. The first was to cut off part of the outer stainless steel structure so that the stainless steel container could be punctured. This involved sawing activated stainless steel. No activity was observed outside the cell during this operation. The stainless steel capsule was then punctured and a gas sample obtained. Care was taken to seal most of the cell openings with masking tape during this operation, and again no activity was observed outside the cell. The assembly was then cut down to a shorter length to obtain a gamma scan to determine fission product distribution. A sharp delineation of the fueled graphite sample was obtained on the gamma scan, indicating that little diffusion of fission products had taken place. The fuel samples, in their impermeable graphite capsules, were removed from the stainless steel can. The two graphite capsules were then exposed for the final sawing operation needed to reach the fuel samples.

April 11, 1960

On about the same date as the start of the disassembly experiment, alterations to Cell 2 were started. These alterations involved drilling seven holes throughout the cell face for the installation of manipulators, a stereomicroscope, a periscope, and a window. At the time of the incident these holes were completely open. The roof slab on Cell 2 was also off to give access, and the back door to the cell was ajar. Thus Cell 2 was open to the back area, the front operating area, and to Cell 1, since the cells at best have about 3 square feet of open interconnection.

April 26, 1960

In Cell 1 [REDACTED] group cut off both ends of the impermeable graphite capsule, taking a 1/16 in. cut on each end which just missed the fueled

graphite sample as planned. A vacuum cleaner was used to collect the graphite sawdust and was reported by visual observation to have collected about two thirds of it. The fuel sample was shaken out of the opened capsule and placed on white blotter paper. Some graphite dust was spilled on the paper during this operation and an air hose was used to blow this dust away. This air hose consisted of a plastic tube attached to the 15-lb air supply and was controlled by a needle valve. It was estimated that this hose was used for about 2 min at a flow rate of 0.1 ft³/min. [REDACTED] group then started taking pictures of the fuel specimen. There is no clear correlation of the time of the activity release with these operations. It probably occurred shortly after the dust was blown away with the air hose. Earlier in the morning Cell 2 had been checked by a Health Physics surveyor prior to carpenters entering in connection with the alterations. Just prior to the activity release, [REDACTED] was engaged in passing APPR fuel specimens through Cell 2 to the Cell 2 extension. The specimens were cleaned and polished; however, there was a possibility that the tray contained some radioactive dust. This transfer had just been completed when the activity release was detected by the constant air monitor. However, radiochemical data indicate the activity release was from the Cell 1 operation.

April 26, 1960
11:00 a.m.

The constant air monitor about 50 ft east and across the operating area alarmed. At this time eight persons, [REDACTED], [REDACTED], [REDACTED], [REDACTED], [REDACTED], [REDACTED], [REDACTED], and [REDACTED] were working directly in front of Cell 1. [REDACTED] was in the area back of the cells completing his transfer. [REDACTED] was working in the laboratory adjacent to the constant air monitor. Eleven other persons were in the hot cell area, mostly in the east end away from Cell 1. About 30 seconds after the alarm sounded, [REDACTED] placed a call to the Health Physics office across the street in Building 3001. [REDACTED] took this call and arrived about 11:02 a.m. and checked the air monitor and found it to be operating but not recording since the inkwell was dry. He also ascertained with a portable survey instrument that the filter paper was reading about 10 mr/hr and that the general area in front of Cell 1 was contaminated to the extent of 100 mr/hr with spots reading 300 to 400 mr/hr. At this time, about 11:05 a.m., he recommended to [REDACTED], who had arrived in the hot cell area with [REDACTED] that the cell area be evacuated, and this recommendation was passed on to the group working in front of the cell who evacuated promptly. After setting up a personnel monitoring station at the connecting door to the west end of the building, [REDACTED] returned to Building 3001 to obtain masks. [REDACTED], [REDACTED], [REDACTED], [REDACTED] and [REDACTED] remained in the hot cell area to close up Cell 2 which was suspected of being the source of activity at that time. They put paper over the openings in the front of the cell, put the roof plug on the cell, closed the back door to the cell and the back door to the building. During this period [REDACTED] observed that the constant air monitor in the area back of the cells located on top of Cell 6 had not shown a significant increase in activity. Later inspection of this instrument showed that the

activity in this back area began to increase about 11:00 a.m. and increased slowly to about twice its original reading by about 2:00 p.m. but did not reach its alarm point. The persons who remained behind to close up Cell 2 evacuated the hot cell area about 11:15 a.m. and joined the group being monitored at the connecting door between the two ends of the building. During the period up to 11:15 a.m. it had become evident that a few persons who had not been in the hot cell area were also contaminated, and that of those persons in the cell area only those who were directly in front of Cell 1 were significantly contaminated. Those persons who were in front of the cell had activity spread over the upper portion of their bodies, hair, shirt, hands, which was in excess of 20 mr/hr, and it was reported that some of their faces were also reading greater than 20 mr/hr. Immediately upon finding that the persons were contaminated to this level, they were given shoe covers and directed to the change room in the basement of the west end of the building where they took showers and scrubbed up. A second monitoring station was set up at this change room to check the progress of their decontamination. Two employees were still sufficiently contaminated that they were directed to the dispensary where nasal decontamination was effected.

April 26, 1960
About 11:15 a.m.

It was realized that a serious release of contamination had occurred and it was recommended that the entire 3025 Building be evacuated as soon as practical. Additional Health Physics help was requested to monitor the persons leaving the building. Approximately 80 persons were evacuated and monitored before they left the building. Of this number, about 30 were found to be contaminated to an extent that decontamination or change of clothing was required. Only 2 persons with significant contamination on their clothing are known to have left the building. They left about 11:00 a.m. before the extent of the incident was known and went to the cafeteria for lunch, thereby contaminating two chairs and a table in the cafeteria. The building evacuation was completed about 11:30 a.m. and personnel monitoring by about 12:15 p.m. However, personnel decontamination continued until about 2:00 p.m.

April 26, 1960
About 12:15 p.m.

Decontamination of the building was started. At this point it was not realized that the activity was primarily air-borne so that only the floors were scrubbed and vacuumed. This operation was continued until about 8:00 p.m. By this time it became evident that areas which had been successfully cleaned were being recontaminated, and it was realized that contamination was continually being distributed throughout the building by the air conditioning system. At 8:00 p.m. it was clearly realized that the activity was air-borne and that the contaminated air conditioning systems were the source of the recontamination. An inspection of the ventilation system indicated that the

entire ventilation system was contaminated. Filters on the two air conditioners in the hot cell area nearest Cell 1 were reading 3-4 r/hr. The air conditioning filters for the west end of the building were reading 40-60 mr/hr. The building ventilation system was then shut down. The subsequent cleanup is described in a separate section on decontamination.

III. Description of Irradiated Specimens and Hot Cell Operations

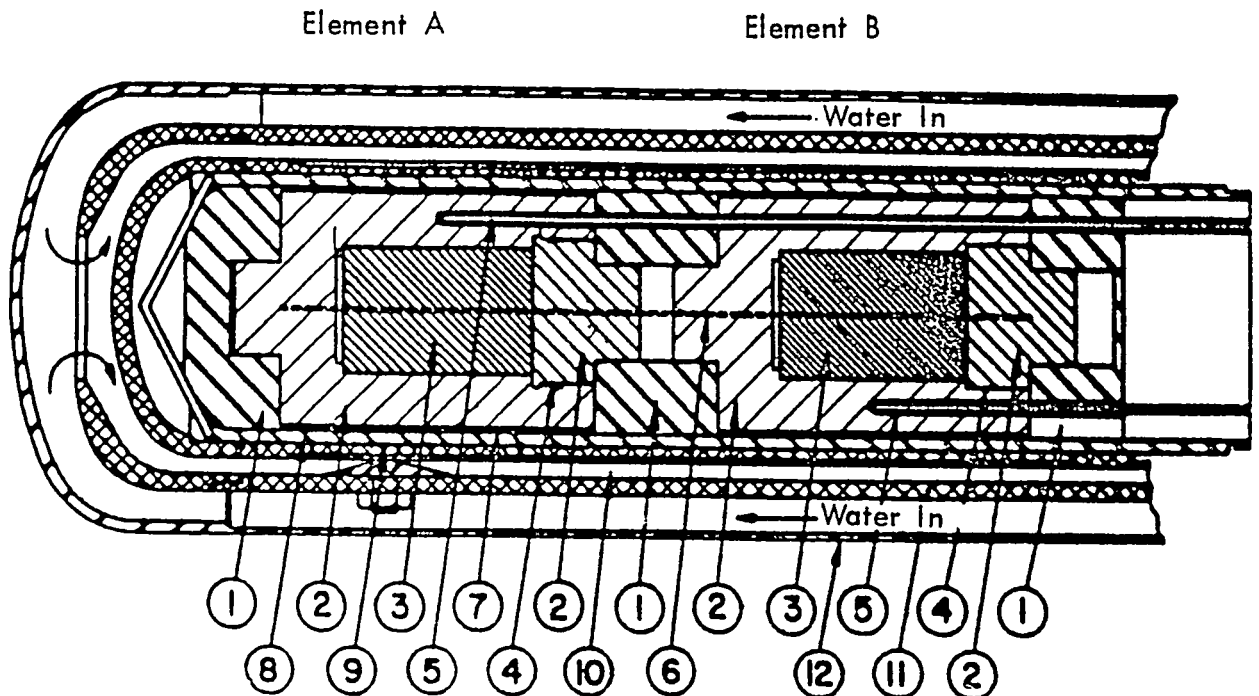
Irradiation data regarding the experiment being examined in Solid State Cell 1 at the time of contamination of Building 3025 is listed below.

ORNL-MTR-48-1 Irradiation Data

	<u>A Element</u>	<u>B Element</u>
Date into reactor	Nov. 2, ¹⁹⁵⁹ 1960	Nov. 2, ¹⁹⁵⁹ 1960
Date out of reactor	Jan. 25, 1960	Jan. 25, 1960
Time at power, hr	1400	1400
Av. thermal neutron flux, n/cm ² .sec	$\sim 4 \times 10^{13}$	$\sim 3 \times 10^{13}$
Av. temperature in graphite, °F		
end toward reactor	1600	1400
end away from reactor	1100	800
Burnup, % U-235	14	6
Burnup, weight U-235, g	0.44	0.37
Date into hot cell	April 18, 1960	April 18, 1960
Date of contamination incident	April 26, 1960	April 26, 1960
Decay time, days	92	92

Figure 2 is an assembly diagram of the fuel-containing section of the experiment, and Fig. 3 is a diagram of element B, the one which was cut open, showing the positions of the saw cuts.

Examination of this experiment was begun by making a saw cut through the outer containment vessel, item 9, Fig. 2. The mixture of helium fill gas and the fission gases evolved from the fuel was collected by piercing a tube attached to the inner containment vessel, item 8, Fig. 2. Another saw cut through both containment vessels allowed removal of the two fuel capsules, elements A and B. The external dimensions of these graphite containers were measured with micrometers. The fuel cylinder was removed from element B by making saw cuts as indicated. It should be pointed out that the fuel cylinder definitely was not cut, since (1) the small shoulder of the graphite container was left intact at one end, and (2) a thin disk



1. Porous carbon 60.
2. R-0020 type graphite.
3. U-235 fueled-graphite-matrix cylinders.
4. Graphite threads sealed with Si-SiC.
5. 316 stainless steel sheathed MgO insulated Cr-Al thermocouples (3) 120° apart per cylinder.
6. Flux monitor wires (3) 120° apart, full length of both fueled-graphite cylinders.
7. Helium gas gap - 0.010 inch.
8. Inner containment vessel - stainless steel 304.
9. Outer containment vessel - 6061 aluminum (with longitudinal grooves).
10. 1/8-inch water flow annulus.
11. Water flow divider - 6061 aluminum.
12. Outer water jacket - 304L stainless steel.

Fig. 2. Diagram of assembly for ORNL-MTR-48 in-pile capsule irradiation test.

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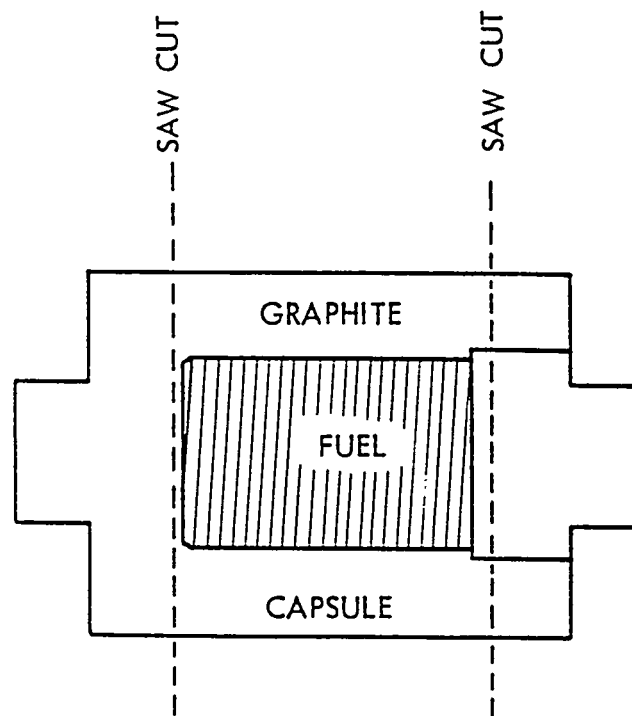


Fig. 3. Element B.

was cut off the end plug at the other end. The fuel cylinder was examined through the periscope and placed on clean white paper in preparation for photography.

IV. Radioactivities Involved in the Incident

The spectral distribution of radioisotopes involved in this incident was unique and no obvious explanation for the observed isotopic distribution has arisen. The activities found generally exhibited the following ratios.

<u>Isotopes</u>	<u>γ Ratios</u>	<u>β Ratios</u>
Gross γ	1	
Ce (141 + 144)	0.9	
Zr-Nb-95	.03	
Co-60	.006	
La-140	.005	
Gross β		1
Ce β (141 + 144)		.55
Trivalent R.E. (primarily Y-91)		.26
Sr β		.15

The ratio of Sr-89 activity to Sr-90 activity was ≥ 10 and the ratio of Ce-144 to Ce-141 activity was 1.3, both ratios being what would be expected from the irradiation and cooling history of the samples.

Since the fuel specimen itself was not cut, but only the graphite capsule, it was expected that those fission products which are volatile or have volatile precursors under the conditions of the experiment (2500°F in a graphite system) should be present in this material. In the case of Ce-144 this did not hold. Ce-144 has no volatile precursor with a significant half life. One might conclude that only activities which are not volatile are involved and that the volatile materials have migrated elsewhere. The small amount of Zr-Nb-95 gamma found contradicts this assumption since these would not be volatile and have no volatile precursors under these conditions. These apparent anomalies can only be resolved by further investigation.

The activity found in the two constant air monitors, in the analysis of fecal samples from the exposed personnel, in smears taken of the general area, in smears taken from the Cell 1 openings, all qualitatively fall into

the above pattern of radioisotope distribution. The discrepancies that exist are minor and can be explained easily by the methods used to prepare the samples for analysis or by the previous history of the samples.

The roof of Building 3025 was found generally contaminated to about 5 mr/hr and in many spots to >20 mr/hr. Samples from this area contained only Ru-106 activity. Therefore, it was concluded that the roof contamination is primarily due to the stack discharge of last year.

V. Personnel Dosimetry

External Dose. The film badges for the 8 men who were most heavily contaminated were processed a few days following the release as a matter of precaution. The highest exposure among these was 120 mr of penetrating radiation, which represented the employee's total external exposure since April 1, 1960, when the film badges had last been changed.

Internal Dose. It is not usually possible to make accurate internal dose estimates within a few weeks following an exposure, particularly when there is a mixture of isotopes and more than one critical organ must be considered. The following information is based upon incomplete data and certain simplifying assumptions with regard to the metabolism of the isotopes involved.

Bioassay samples were taken from all persons who were in the building at the time of the release. Initially, the analysis of these samples was limited to the 8 most heavily contaminated persons. As of May 16, samples from 25 of the other persons in the building have been analyzed and none has shown activity in excess of the lowest of the 8 present at the cell face. Whole body counter measurements and additional urinalysis were performed on 7 employees. (The eighth is an employee of the National Carbon Company. Arrangements are made for obtaining body counter and additional bioassay data for this man.)

Available body counting data indicate that the material is localized in the lungs, and both urinalysis and body counting data indicate that the material is being eliminated from the lungs at an unusually high rate. At 10 days following the exposure, about 75% of the original lung burden of 2.4 microcuries of strontium had been eliminated from the lungs in the case of employee "A" below. Solubility measurements of typical contamination samples in blood serum have been made and tend to confirm the high rate of removal of the activity from the lungs. Following are estimates of the dose to the lungs and bone of the 8 employees. The dose to the lungs assumes that all material in the lungs as of 10 days following the incident is removed only by radioactive decay. The dose to the bone assumes that about one-half of both the cerium and the strontium due to leave the lungs by way of the bloodstream is deposited in the bone.

Current Estimates of Internal Dose*
(Preliminary)

Employee	Lung		Bone	
	1st Quarter REM	1st Year REM	1st Quarter REM	1st Year REM
A	1.18	2.09	1.14	2.24
B	0.30	0.53	0.29	0.56
C	0.11	0.19	0.10	0.20
D	< 0.10	0.17	< 0.10	0.19
E**	< 0.10	0.16	< 0.10	0.17
F	< 0.10	< 0.10	< 0.10	0.10
G	< 0.10	< 0.10	< 0.10	< 0.10
H	< 0.10	< 0.10	< 0.10	< 0.10

* Greater than 90% of the dose estimated for the lungs and the bone will be from the strontium isotopes.

** National Carbon employee--dose estimated on the basis of a single urine and fecal sample.

Studies will continue in order that these exposures can be estimated with more certainty.

VI. Decontamination of Building 3025

When it was realized at 8:00 p.m. on April 26 that the building was being contaminated with air-borne activity, the air conditioning system was shut off, both interconnecting doors between the old portion and the new portion of the building were sealed, and air monitors were set up. Additional janitorial help was enlisted and a 24-hour work schedule was initiated. The east end of the old portion was only slightly contaminated, and the cell change room was usable after a plastic shield was set up at the end of the entrance hall at the east end of the second floor. A change room was also set up at the southwest corner of the new portion of the building.

Cleaning of the ventilation system began with removal of the contaminated filters. Next the supply and exhaust diffusers were cleaned by vacuuming and washing with detergent. Ducts were vacuumed as far back as could be reached with extension hoses. In some cases where activity was detected and could not be reached, an entry port was cut in the duct to permit access for cleaning. When cleaning of the ventilation system was completed, two layers of American Air Filter Air Mat, Type G, filter paper were installed behind each supply fixture.

After the air handling system was cleaned it was turned on and allowed to run for about 12 hours. Air samples taken during this period showed that the air supplied to the building uniformly contained about 10^{-11} - 10^{-12} $\mu\text{c/cc}$, well below tolerance for the radioisotopes involved. However, the air flow had been reduced to 60% of normal by the filters over the supply fixtures. The decision was then made to move both layers of the room supply filters, autoradiograph them, and replace them with a single layer of American Air Filter Air Mat, Type G. The autoradiographs showed that very little radioactivity was present in the circulating air in the new portion of the building. Again the system was turned on, the air sampling repeated, and the system was found to be delivering clean air.

Work was then continued on cleaning the labs and offices. Contamination was located by means of a probe and the area marked. Since the contamination was particulate in nature, practically all of it was very effectively removed by vacuuming. If the radioactivity was not removed by vacuuming, scrubbing with a detergent was employed. In the few cases which required more strenuous treatment, the area was sprayed with paint of a distinctive color and special decontamination techniques such as removal of paint and tile were used. After cleaning, a very thorough probing was given all areas. Before occupancy, final checking by smearing was carried out.

As of May 12, seventeen days after the release of active material, the air system of the new portion of Building 3025 has been monitored and found to deliver clean air. The offices, labs, and halls have been probed, smeared, and with but few exceptions found to be within tolerance for use. The exceptions are expected to be cleaned by May 16, 1960.

In the old portion of the building, the cell operating area has been cleaned but only a spot check made for residual activity. The first floor in the old portion of the building is more contaminated and will require additional decontamination time.

VII. Conclusions

1. In retrospect, the Committee feels that the primary cause of this incident was that a reactor fuel capsule of an advanced type and completely new to the persons involved was being handled with procedures and equipment which were inadequate to cope with the unusual hazard involved.
2. Under the existing conditions, the incident was capably handled by all persons and groups involved. However, the following conditions could have contributed to making the accident much more serious than it was.
 - (a) Inadequate radiation monitoring equipment was available to determine the extent and nature of the activity released. Not until 8:00 p.m., 9 hours later, was it clearly realized that the continued spread of activity was implemented by the air conditioning system. (An additional air monitor for installation in the west end of Building 3025 had been requested on August 20, 1957, but approval was not obtained.)
 - (b) No emergency communication system was available, and at least 15 minutes were required to alert the building occupants that a radiation release had occurred.
 - (c) No masks or other emergency supplies were readily available; and after they were aware that air-borne activity was present, five persons remained in the area without masks to secure the cells.
 - (d) While urine samples were taken from all persons involved in the incident, most were not analyzed up to May 8, 12 days after the incident.
3. The sawing of a heavily contaminated graphite capsule in Cell 1 was an unusually hazardous operation, since a radioactive dust, easily suspended in air, was created. Prior to the incident no one properly assessed the extent of this hazard.
4. The facility, in addition to not being equipped for such an operation, was in a dangerous state. For instance, the off-gas filters were bad, the adjoining cell was wide open, the cell pressure was dangerously near that of the operating area, and the back door to the building was left open.
5. The flow and recirculation of air throughout the entire building, from hot cell areas to office-laboratory areas, was contrary to good practice, and previous incidents somewhat similar to this one but of lesser extent were common knowledge of persons familiar with this area.

6. The persons carrying out the experiment, in view of the unusual hazard involved, were not sufficiently aware of Health Physics fundamentals, safety, and the limitations of the facility in which they were working.
7. Established procedures in the Solid State Division for insuring safe operation in this area were not employed, and as a result no outside help, such as Health Physics, was called in for evaluation of hazards. No specific consideration of hazards was included in the experiment description prepared for hot cell work.

VIII. Recommendations

1. A comprehensive set of criteria for safe operation in hot cells for Oak Ridge National Laboratory (an outline of our suggested minimum containment standards is given in attachment A) should be established, and all hot cell operations at the laboratory should be reviewed to determine whether they meet such minimum standards.
2. Until hot cell facilities at Oak Ridge National Laboratory are made to meet the minimum containment standards, each experiment which could conceivably result in unusual personnel exposure or ingestion, in an unusual contamination problem, in operational interruption, or an incident of public relations significance should be subjected to extra-Divisional review.
3. In addition to establishing criteria for safe hot cell operation at Oak Ridge National Laboratory, management should establish a mechanism for insuring compliance with these criteria.
4. Emergency procedures and a trained emergency organization with proper emergency equipment should be established for all hazardous areas.
5. A general educational program in radiation safety and control should be established for personnel at Oak Ridge National Laboratory working with radioactive materials.

Submitted:

F. R. Bruce
F. R. Bruce, Chairman

D. E. Ferguson
D. E. Ferguson

J. A. Richard
J. A. Richard

G. W. Parker
G. W. Parker

Attachment A

Outline of Minimum Standards for Hot Cells

1. A minimum of 0.1 in. of water vacuum must be maintained on hot cells and a minimum flow through any opening of at least 100 ft/min with sufficient exhaust capacity that these minimum values can be maintained for any creditable situation that may arise, and an alarm provided to indicate when the vacuum drops below 0.1 in. of water.
2. Exhaust from hot cells must pass through at least one roughing filter and an absolute filter and be continuously monitored with an alarm before being discharged to the environment.
3. For any operation which is likely to produce gross amounts of air-borne contamination, an additional line of containment within the cells should be provided with an exhaust which is filtered before discharging into the cell ventilation or other suitably filtered system.
4. Provision must be made for removing chemical contamination from the cell offgas such that the filters are not impaired and special, chemical resistant filters used where needed.
5. Vacuum lines run into cells should be adequately trapped, treated for chemical contamination, and filtered before leaving the shielded area.
6. All known liquid radioactive effluents should be routed to the appropriate hot waste system.
7. All other possible routes of radioactive material release, such as process water drains within the cells should be monitored and provision made for diversion to the hot waste system made. Process water should not be discharged to the hot waste system except in case of an emergency.
8. All operations in hot cells which involve unusual hazards, such as, large quantities of alpha or soft beta activity which are difficult to detect; gaseous activity; possibility of an uncontrolled chemical reaction, fire, or explosion; and possibility of a critical assembly should be individually reviewed by the director of Radiation Safety and Control.
9. The area around hot cells up to a second line of contamination control should be regarded as a likely contamination zone, and monitoring for all persons and materials leaving this clearly defined zone should be mandatory.

10. Adequate radiation detection instruments should be present in such areas to give prompt indication of air-borne activity, any significant spread of contamination, or an increase in background activity.
11. In addition to a line of contamination control, provision for a complete second line of containment should be provided around hot cell areas, such that, when a radiation release is detected, the area is automatically isolated and exhausted through a filter, if practical the cell ventilation system.